

Solar Dynamo: Old Problems and New Challenges

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Abstract

Solar activity is driven by the magnetic fields that originate deep within the convection zone. The fields are believed to be generated by a dynamo utilizing the solar rotation and convective motions. Although some researches still advocate the fossil origin of the solar magnetic fields.

Here we discuss dynamo theories and related models of instabilities which result in the emergence of magnetic flux to the solar surface. Magnetic field generated by dynamo is predominantly azimuthal and can be unstable to the formation of flux tubes. Simulations indicate that the emergence of the magnetic flux tubes strongly depends on the field strength and its longitudinal distribution at the bottom of the convection zone. In a unifying approach advocated in this talk the solar magnetic field is split into a mean part generated by the mean-field dynamo and a fluctuating part approximated by an ensemble of flux tubes. Among the old problems we discuss the distribution of sources of the mean-field in the solar convection zone and generation of the non-axisymmetric modes of the field.

We indicate that the identification of the longitudinal distribution of emerging photospheric magnetic fields can give us information about the magnetic field strength at the bottom of the convection zone. Distinguishing between the modes of emerging field requires simultaneous magnetic imaging of both sides of the Sun. This challenge will be taken by the Farside mission planned in the NASA Living With a Star Initiative. Correlation of simultaneous Dopplergrams of the photosphere from earthside and from the farside of the Sun opens an opportunity to detect velocity structures at the base of the convection zone, associated with the dynamo and emerging active regions. This global imaging of the photosphere can also be used for detection of a magnetic field in the solar core.